

REMARKS

Applicants have cancelled dependent claims 84 and 132 because they are now redundant to the independent claims. Claims 84 and 132 recited "said product is adapted for administration of said Vitamin D compound on a less frequently than daily basis." That same limitation now appears in independent claims 75 and 125.

Applicants have also amended dependent claim 127. Claim 127 as set forth in the Amendment on June 27, 2005 recited that the Vitamin D compound was "Vitamin D3 (cholecalciferol)." However, in the next amendment filed on August 30, 2005, applicants erroneously amended the claim to changing the compound to "calcitriol." Calcitriol would not fit within the independent claim and the dependent claim should read "cholecalciferol" as submitted on June 27, 2005.

Applicants have amended dependent claims 140-153 to reflect that they depend off of claim 139, rather than claim 134. This typographical error occurs in claims 140-153.

Finally, applicants have amended the specification to correct a typographical error that repeats eight times in the specification (but does not appear on any allowed claims). The typographical error appears throughout the patent application whenever dosages of Vitamin D compounds are expressed in gram-type units, specifically "mg" (milligram) units. In all of those instances, the designation "mg" should read "mcg" (micrograms). A person skilled in the art would recognize this as a typographical error based on a review of both the specification and the 1989 publication of the Food and Nutrition Board of the United States National Research Council, referred to explicitly in the specification.

Specifically, the typographical nature error is shown by the reference in the patent specification to the recommended daily dietary allowances of Vitamin D set forth in the "Food

and Nutrition Board of the United States National Research Council from 1989." On page 4, line 14, to page 5, line 3, of the specification, applicants state:

"Recommended daily dietary allowances of Vitamin D by the *Food and Nutrition Board of the United states National Research Council (1989)* were 10 mg cholecalciferol (400 IU Vitamin D) daily for females age 11-24 and 5 mg cholecalciferol (200 IU Vitamin D) daily for females age 25 and older."

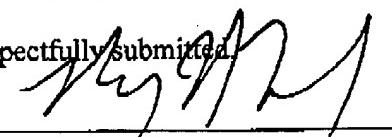
Attached at Tab A is a copy of the "Food and Nutrition Board of the United States National Research Council from 1989" cited in the specification.

As shown in the attached publication of the Food and Nutrition Board of the United States National Research Council, 400 IU Vitamin D correlates to *10 µg* (mcg or micrograms) of cholecalciferol, not 10 mg. (see Tab A, page 96). Similarly, 200 IU Vitamin D correlates to *5 µg* (mcg or micrograms) of cholecalciferol, not 5 mg. (see Tab A, page 96). Although not necessary, a quick Google search shows numerous references confirming that 400 IU Vitamin D correlates to 10 mcg of cholecalciferol, and 200 IU Vitamin D correlates to 5 mcg of cholecalciferol.

The typographical error applies to the eight references to Vitamin D dosages in "mg" units in the patent application. A person skilled in the art would recognize that "mcg" was appropriate for all the references to "mg" in the specification by reading the 1989 Food and Nutrition Board publication and given the types of dosages of calcitriol given in the art.

Applicants respectfully seek entry of the foregoing amendments.

Respectfully submitted,

  
Raymond N. Nimrod

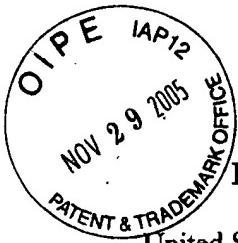
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I hereby certify that this Amendment with Tab A is being facsimile transmitted to the United States Patent and Trademark Office Fax No. (571 273-2885) on November 29, 2005.

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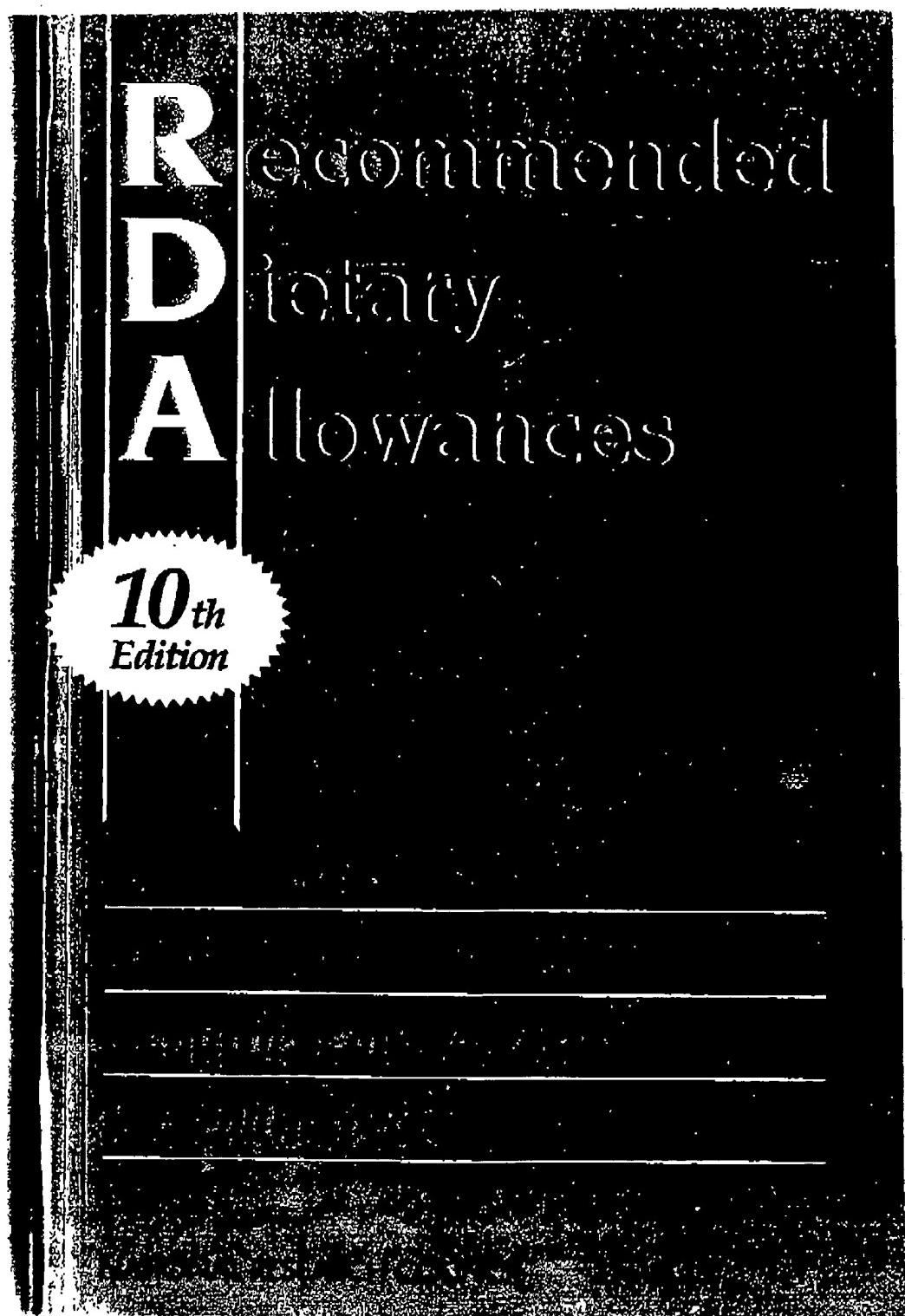
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# TAB A



# Recommended Dietary Allowances

*10th Edition*

Subcommittee on the Tenth Edition of the RDAs  
Food and Nutrition Board  
Commission on Life Sciences  
National Research Council

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The Food and Nutrition Board wishes to acknowledge the contributions of the Committee on Dietary Allowances that worked on the tenth edition from 1980 to 1985. The committee was chaired by the late Henry Kamin of Duke University Medical Center. Other members of the committee were Philip Farrell (University of Wisconsin, Madison), Helen A. Guthrie (Pennsylvania State University), Victor Herbert (Veterans Administration Medical Center, Bronx, New York), Robert Hodges (University of California, Irvine Medical Center), Max K. Horwitt (St. Louis University School of Medicine), Orville Levander (U.S. Department of Agriculture), Hellen Linkswiler (deceased; University of Wisconsin, Madison), James A. Olson (Iowa State University), and Peter L. Pellett (University of Massachusetts, Amherst). The Food and Nutrition Board staff included Myrtle L. Brown (executive secretary until August 1983), Sushma Palmer (director from July 1983), Linda D. Myers (project director), Frances M. Peter (editor), Marianne E. La Veille (research associate), and secretaries Susan Barron, Shirley E. Cole, Avis I. Harris, and Janie B. Marshall.

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## VITAMIN D

Vitamin D (calciferol) is essential for the proper formation of the skeleton and for mineral homeostasis. Exposure of the skin to ultraviolet light catalyzes the synthesis of vitamin D<sub>3</sub> (cholecalciferol) from 7-dehydrocholesterol. The other major form of the vitamin, D<sub>2</sub> (ergocalciferol), is the product of the ultraviolet light-induced conversion of ergosterol in plants. The effectiveness of exposure to sunlight or ultraviolet light in curing or preventing rickets was shown early in the twentieth century (Chick et al., 1923).

*General Signs of Deficiency*

Vitamin D deficiency is characterized by inadequate mineralization of the bone. In children, severe deficiency results in deformation of the skeleton (rickets). In the adult, vitamin D deficiency leads to undermineralization of the bone matrix osteoid; the resulting hypocalcemia is accompanied by secondary hyperthyroidism that can lead to excessive bone loss and, in the extreme, bone fractures (osteomalacia) (Nordin, 1973). The prolonged periods required to produce vitamin D deficiency in animals and humans is attributed to the slow release of vitamin D-related steroids from fat depots and skin.

Because milk and other foods are fortified with vitamin D, rickets is very rare in many countries. However, vitamin D deficiency occurs in some infants who are breastfed without supplemental vitamin D or exposure to sunlight (Edidin et al., 1980; Hayward et al., 1987), in the elderly (Egmose et al., 1987; Omdahl et al., 1982; Reid et al., 1986), and in people with vitamin D malabsorption (Rosen and Chesney, 1983). Abnormalities in calcium homeostasis and bone metabolism can also occur when the conversion of vitamin D to biologically active forms is compromised due to disease states. For example, rickets and osteomalacia are often found in patients with kidney failure (Haussler and McCain, 1977).

#### *The Dietary Essentiality of Vitamin D*

The vitamin D requirement of humans can be met if their skin is exposed to a sufficient amount of sunlight or artificial ultraviolet radiation. The amount of vitamin D synthesized by this means is dependent on the area of skin exposed, the time of exposure, and the wavelength of the ultraviolet light impinging on the skin. Practical considerations are the latitude of the person's residence and the season of the year (Lawson, 1980; Webb et al., 1988). Exposure to sunlight can be further limited by customs of dress and by the institutionalization and extensive indoor residency of the ill and aged. The character of the skin also influences the efficiency of vitamin D<sub>3</sub> synthesis. Compared to lighter skin, skin with high melanin content requires a much longer exposure to ultraviolet light to achieve the same degree of synthesis (Clemens et al., 1982). The capacity of skin to synthesize vitamin D<sub>3</sub> in the elderly is approximately half that of younger people (Webb et al., 1988). Given the many factors that can affect the magnitude of ultraviolet light-dependent synthesis of vitamin D<sub>3</sub>, vitamin D should be considered an essential dietary nutrient.

#### *Biochemistry and Metabolism*

The biochemistry and metabolism of vitamin D have been extensively reviewed (DeLuca, 1988; Fraser, 1988). Among the metabolites of vitamin D are 25-hydroxyvitamin D [25(OH)D, or calcidiol], which is formed in the liver and further hydroxylated in the kidney to yield 1,25-dihydroxyvitamin D [1,25(OH)<sub>2</sub>D, or calcitriol], and 24, 25-dihydroxyvitamin D [24,25(OH)<sub>2</sub>D]. In addition to ensuring adequate absorption of calcium, 1,25(OH)<sub>2</sub>D contributes to plasma calcium regulation by increasing bone resorption synergistically with para-

thyroid hormone and stimulating the reabsorption of calcium by the kidney.

Dietary vitamin D is readily absorbed from the small intestine and transported in chylomicrons to the liver, where conversion to 25(OH)D takes place (DeLuca, 1979). Vitamin D from the liver and vitamin D synthesized in the skin are transported in the blood largely bound to a vitamin D-binding protein and albumin, as are 25(OH)D and 1,25(OH)<sub>2</sub>D. The liver is the major site of vitamin D deactivation. Some of the metabolites of the vitamin excreted in bile are reabsorbed, but this process contributes little to the maintenance of vitamin D status.

Vitamin D status is reflected primarily by the concentrations of 25(OH)D and 1,25(OH)<sub>2</sub>D in the blood. In surveys of large groups of healthy people, the mean value of 25(OH)D ranges from approximately 25 to 30 ng/ml (Rosen and Chesney, 1983). The concentrations of 1,25(OH)<sub>2</sub>D range from 18 to 60 pg/ml of plasma in normal children and between 15 to 45 pg/ml in healthy adults. Despite the wide range of normal values, there is no seasonal variation in plasma 1,25(OH)<sub>2</sub>D (Chesney et al., 1981); this implies tight regulation.

One international unit (IU) of vitamin D is defined as the activity of 0.025 µg of cholecalciferol in bioassays with rats and chicks. Thus, the biological activity of cholecalciferol is 40 IU/µg. The activity of 25(OH)D and 1,25(OH)<sub>2</sub>D are approximately 1.5 and 5 times, respectively, greater than that of vitamin D.

#### *Dietary Sources and Usual Intakes*

In the United States, foods fortified with vitamin D are a major dietary source of the vitamin.<sup>a</sup> Processed cow's milk, which contains 10 µg of cholecalciferol (400 IU) per quart, contributes most of the vitamin ingested by children. Infant formulas are fortified with the same amount as milk. Human milk contains 0.63 to 1.25 µg of cholecalciferol per liter (Reeve et al., 1982; Tsang, 1983). The usual solid food sources are eggs, butter, and fortified margarine. The vitamin is stable in foods. Storage, processing, and cooking do not appear to affect its activity.

In the United States, the usual dietary intake has been estimated primarily for infants and children. Calculations based on reference

<sup>a</sup>Vitamin D occurs as cholecalciferol or ergocalciferol in foods and fortified food products. Since the chemical forms are generally not separately identified, the vitamin D content of foods and dietary intakes are given in micrograms of cholecalciferol for simplicity.

infants and the data of Fomon (1974) indicate that daily intakes of vitamin D from formula are 6.75 µg of cholecalciferol for the infant from birth to 3 months of age and 8.5 µg of cholecalciferol at 4 to 6 months. In contrast, the average breastfed reference newborn receives only 0.38 to 0.75 µg of cholecalciferol per day from 750 ml of human milk (AAP, 1985; Reeve et al., 1982). Children drinking three 8-oz glasses of milk daily consume about 7.5 µg of cholecalciferol plus a small amount in other foods. Data from the USDA show that the average adult male ingested 2.1 µg of cholecalciferol from milk (USDA, 1986), whereas females consumed 1.5 µg (USDA, 1987). Omdahl et al. (1982) reported that a population of 60- to 93-year-old subjects had a median dietary intake of 1.35 µg of cholecalciferol (females) and 1.95 µg of cholecalciferol/day (males); 15% of the total study population, especially women, had plasma 25(OH)D levels suggestive of deficiency.

#### *Recommended Allowances*

Establishing an RDA for vitamin D is difficult because exposure to sunlight results in synthesis of vitamin D by the skin. People regularly exposed to sunlight, under appropriate conditions, have no dietary requirement for vitamin D. However, since a substantial proportion of the U.S. population is exposed to very little sunlight, especially during certain seasons (Stryd et al., 1979), a dietary supply is needed.

*Adults* Data to assess vitamin D requirements of adults are limited. Dent and Smith (1969) summarized studies of seven adult females living in the United Kingdom and suffering from nutritional osteomalacia due to vitamin D deficiency. They were either strict vegetarians or had unusual diets that rigidly excluded most fats. In all the patients, vitamin D intake was estimated to be below 1.75 µg (70 IU) per day and small additional amounts of vitamin D resulted in improved calcium utilization. On the basis of these studies and other observations on similar patients, Dent and Smith suggested that the adult vitamin D requirement was about 2.5 µg (100 IU) per day.

The relative paucity of recent controlled studies in humans and the lack of data on the variability of vitamin D requirements have led this subcommittee to keep the RDA for vitamin D for adults beyond 24 years of age at 5 µg (200 IU)—the same level recommended in 1980. It seems likely that this is a generous allowance. Data from USDA's 1977–1978 Nationwide Food Consumption Survey indicate that 1.25 to 1.75 µg/day (50 to 70 IU) is the usual dietary intake in the United States (USDA, 1983). Presumably, vitamin D

stores are enriched in most people by regular exposure to sunlight, at least during certain times of the year. Clinical nutritional osteomalacia appears to be rare in the United States.

**Pregnancy and Lactation** It has not been determined whether or not there is an increased need for vitamin D during pregnancy, but since calcium is deposited in the growing fetus, a daily increment of 5 µg (200 IU) is recommended for women beyond 24 years of age. Although only small amounts of vitamin D are secreted in human milk, an increment of 5 µg (200 IU) per day is recommended for lactating women beyond age 24 because of the importance of maintaining calcium balance. The vitamin D RDA for both pregnant and lactating women of all ages is 10 µg/day (400 IU).

**Infants and Children** Several reports have questioned whether human milk contains sufficient vitamin D to prevent rickets in the absence of exposure to sunlight (Finberg, 1981; Greer and Tsang, 1983; Tsang, 1983). In full-term infants fed human milk, bone mineral content, total and ionized calcium in serum, and serum phosphorus and alkaline phosphatase values were similar to those in a comparison group fed infant formula containing 10 µg (400 IU) of vitamin D per quart, but serum 25(OH)D concentrations were lower in the babies fed human milk (Roberts et al., 1981). In a randomized, double-blind study, bone mineral content was less in babies fed human milk without supplemental vitamin D than in those who received 10 µg/day (400 IU) (Greer et al., 1982). In a study of premature infants, 2.5 µg (100 IU) of vitamin D daily was associated with rickets and abnormalities in alkaline phosphatase activity in some infants (Claser et al., 1949); however, these abnormalities may have been due to dietary mineral deficiency (Steichen et al., 1981). To provide a margin of safety, the RDA is set at 7.5 µg (300 IU) for infants from birth to 6 months of age. Breastfed infants who are not exposed to sunlight should receive a daily supplement of 5 to 7.5 µg (200 to 300 IU).

The allowance for children older than 6 months of age has been set at 10 µg (400 IU) because of their increased body mass. Because peak bone mass is not achieved before the third decade, this allowance is recommended through age 24 years. This amount should be readily achievable at current levels of vitamin D fortification of foods.

#### *Excessive Intakes and Toxicity*

Vitamin D is potentially toxic, especially for young children. The effects of excessive vitamin D intake include hypercalcemia and hy-

percalciuria (Haussler and McCain, 1977), leading to deposition of calcium in soft tissues and irreversible renal and cardiovascular damage. Although the toxic level has not been established for all ages, consumption of as little as 45 µg (1,800 IU) of cholecalciferol per day has been associated with signs of hypervitaminosis D in young children (AAP, 1963). Since the toxic level of vitamin D may in some cases be only 5 times the RDA, and there is evidence that sunlight-stimulated production of the vitamin is active throughout the warm months, dietary supplements may be detrimental for the normal child or adult who drinks at least two glasses of vitamin D-fortified milk per day (AAP, 1963).

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